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5. The method of claim 1, further comprising performing the welding in an inert atmosphere.

6. The method of claim 5, wherein said inert atmosphere is argon.

7. A method of edge welding, comprising:

A. applying a laser beam onto a seam of a first element and a second element,

i) where said laser beam comprises

a. a diameter and

b. sufficient energy to melt a portion of said first and said second element

onto which it is applied, and

B. oscillating said laser beam such that a laser spot of said laser beam scans back and forth across said seam,

wherein oscillating said laser beam creates an effective laser spot size larger than said diameter of said laser beam; and

C. moving said oscillating laser beam along said seam,

wherein said first element and said second element are welded as said oscillating laser beam moves along said seam.

8. The method of claim 7, wherein a portion of the laser spot misses the seam,

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further comprising redirecting the portion of the laser spot onto the seam.

9. The method of claim 7 wherein said effective laser spot size ranges from two to four times the size of said seam.

10. The method of claim 7 wherein said laser beam is produced by a laser selected from the group consisting of Nd:YAG, Nd:Glass, Nd:YVO, CO, CO₂, Cr:Ruby, diode laser, diode pumped laser, and derivatives thereof.

11. The method of claim 7, further comprising performing the welding in an inert atmosphere.

12. The method of claim 11, wherein said inert atmosphere is argon.

13. A method of edge welding, comprising:

A. welding a seam of a first element and a second element comprising:

i) directing a laser beam onto a beam splitter, whereby two laser beams are created;

ii) redirecting both of said two beams through a focusing lens, whereby said two laser beams are focused onto said seam of said first element and said second element;

a) where said two laser beams comprise

i. a diameter and

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ii. sufficient energy to melt a portion of said first and said second element onto which it is applied, and

b) oscillating said two laser beams such that a laser spot of said two laser beams scans back and forth across said seam,

wherein oscillating said two laser beams creates an effective laser spot size larger than said diameter of said two laser beams; and

c) moving said oscillating two laser beams along said seam, wherein said first element and said second element are welded as said oscillating two laser beams move along said seam.

14. The method of claim 13, wherein a portion of the laser spot misses the seam, further comprising redirecting the portion of the laser spot onto the seam.

15. The method of claim 13, wherein said effective laser spot size ranges from two to four times the size of said seam.

16. The method of claim 13, wherein said laser beam is produced by a laser selected from the group consisting of Nd:YAG, Nd:Glass, Nd:YVO, CO, CO₂, Cr:Ruby, diode laser, diode pumped laser, and derivatives thereof.

17. The method of claim 13, further comprising performing the welding in an inert atmosphere.

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18. The method of claim 17, wherein said inert atmosphere is argon.

Claims 2-18 are added by the present amendment. Presently pending before the Examiner are claims 1-18. Independent claims 7 and 13 have been rewritten to include the limitations of claim 1. Independent claim 7 differs from independent claim 1 by the addition of the term "edge" to the preamble and the correction of some antecedent terminology issues. Support for the term "edge" can be found throughout the specification, including page 2, lines 13-15; page 4, lines 19-20; and page 7, lines 13-14. Independent claim 13 differs from independent claim 1 by the addition of the process of beam splitting utilized in the inner diameter welding system and the correction of some antecedent terminology issues. Support for this amendment can be found throughout the specification, including page 7, lines 29-30; page 8, lines 1-9; page 9, lines 13-23. Support for claims 2, 8 and 14 can be found throughout the specification, including page 4, lines 29-30; page 5, lines 1-4; and page 6, lines 16-20 of the specification. Support for claims 3, 9 and 15 can be found throughout the specification, including page 10, line 30 through page 11, lines 1-3 and page 19, lines 5-6. Support for claims 4, 10 and 16 can be found throughout the specification, including page 12, lines 3-12. Support for claims 5, 6, 11, 12, 17 and 18 can be found throughout the specification, including page 12, lines 13-29.

No new matter has been added by these amendments. It is Applicant's position that the amendments made herein are broader than actually required by the prior art and should not be

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construed as limiting any future doctrine of equivalents to matter that was not anticipated. However, to advance prosecution, and also to ease claim drafting, Applicant's contend that these amendments place the application in a condition for allowance.

35 U.S.C. 102

The Examiner has rejected claim 1 under 35 U.S.C. 102(b) as being anticipated by Esaka *et al.* (U.S. Pat. No. 5,841,097). Claims 1-18 are presently before the Examiner for consideration. Newly filed claims 2-18 add limitations to original claim 1 that were contained in the original specification. The invention taught by claims 1-18 are not present in, nor obvious over Esaka *et al.*

In order to assist Examiner in advancing allowance of the present application, arguments addressing obviousness have also been provided. Based on the prior art provided by Examiner and the patentability search conducted prior to filing the present application, it is Applicants' position that the method claimed is novel and non-obvious for the following reasons:

A. Oscillation Frequency

Esaka *et al.* discusses in the Background of the Invention that it is not desirable to oscillate the laser beam with a short period (at a high frequency) (col. 2, lines 50-53). Esaka *et al.* discusses in the Summary of the Invention that their process does not require an increase in the oscillation frequency of the laser beam spot (col. 2, lines 63-67). The present invention, as

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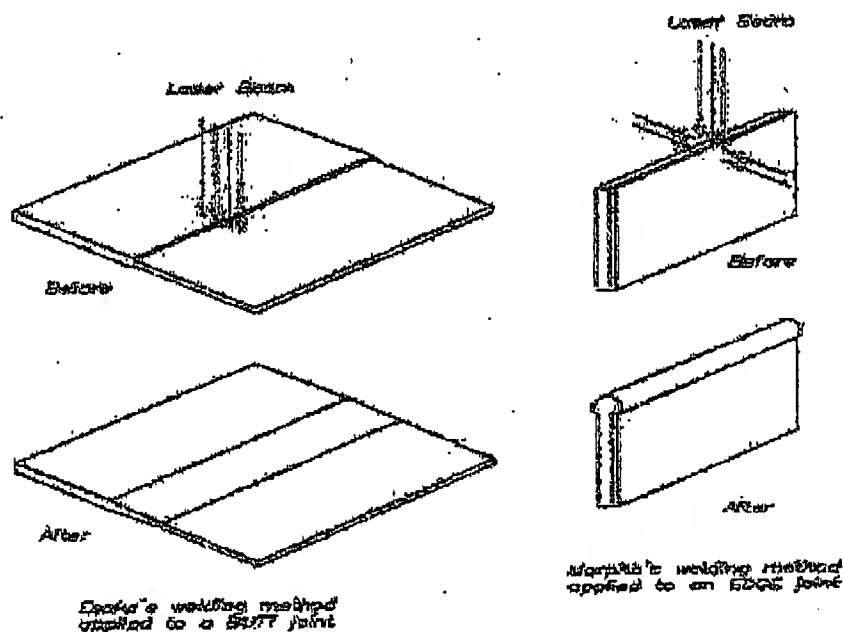
originally claimed and as presently pending in the amended claims, requires a high oscillation frequency. Claim 1 as originally filed and the independent claims filed herewith claim "...wherein oscillating the laser beam creates an effective laser spot size larger than the laser spot size..." Clearly, Esaka *et al.* do not anticipate these claims because Esaka *et al.* teach that oscillation should be performed at a low frequency and the present application claims that the oscillation has to be so fast as to create the visual impression of a laser beam larger than actually used.

B. Joint Type

Many types of welded joints are known in the art, including, but not limited to, butt joints, single-welded butt joints, double-welded butt joints, lap joints, single-welded lap joints, double-welded lap joints and edge joints. Esaka *et al.* teaches welding butt joints (see claim 1). Butt joints are defined as a welded joint between two abutting parts lying in approximately the same plane (see diagram below). The claims of the present application are directed to edge joints. Edge joints are defined as a welded joint connecting the edges of two or more parallel, or nearly parallel parts (see diagram below). The difficulties encountered in these two welding types are significantly different. For example, in butt welding, material ejection is a major issue. If the power of the laser is too high, material is ejected from the keyhole with considerable velocity and may end up damaging the laser lens. Edge welding utilizes a conduction process, in

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which material ejection is unlikely because the laser power is absorbed on the surface of the weld. The claims of the present invention are directed to edge welding, which is well known in the art to present problems and solutions unique thereto. It would be impossible to use the butt welding method of Esaka *et al.* in the teachings of the present invention because the oscillation frequency taught by Esaka *et al.* and commonly used in butt welding techniques would actually result in poor edge weld integrity and possibly even edge weld failure.



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C. Laser Output and "Hot Spots"

Both Esaka *et al.* and the present Applicants address issues encountered using lasers, commonly referred to as "hot spots." However, Esaka *et al.* focus on hot spots concerns the effect of the entire laser output (see col. 2, lines 14-18). Esaka *et al.* move the laser in a sinusoidal wave. The material encountering the laser melts more quickly than the materials with which the laser does not come into contact. The material that melts more quickly, the hot spot, provides the undesired result of uneven melting.

The present application also addresses laser use issues known as "hot spots." However, here the term refers to energy distribution within the laser itself. It is well known that the power output from a laser can vary due to, for example, dopant distribution in the laser rod, age of the pump lamp, reflectivity of the pump chamber, temperature variations in the cooling water, mirror alignment, dust contamination, variations in the power supply, and temperature variations in the optical rail. With a static beam, these hot spots are often reflected in the molten material of the weld pool. Because of the small size of the weld pool, and the motion of the seam away from the molten area, rapid hardening of the molten material occurs upon leaving the weld pool. Thus, any asymmetric melt due to hot spots in the laser beam is preserved in the weld, resulting in a lopsided appearance of the weld bead and possible weld failure. The present inventors have found that oscillating the laser beam removes this issue, particularly when the laser beam is oscillated at a high frequency. Once again, Esaka *et al.* teach that their oscillation should be

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performed at a low frequency. Clearly, Esaka does not anticipate nor render obvious the present invention because of these significant differences.

D. Oscillation in the millimeter range

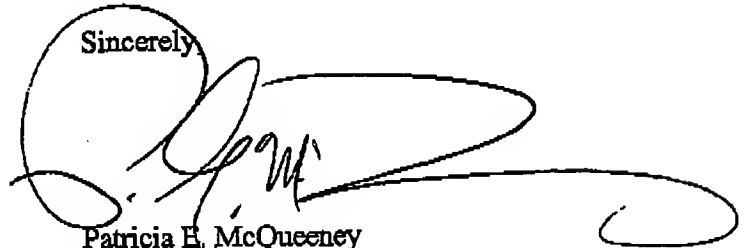
Finally, one of ordinary skill in the art would not expect the method of Esaka *et al.* to be successful when used on objects whose thickness would not be expected to support oscillation. As evidenced by the patents to Chang, the current state of affairs in welded bellows is to utilize a relatively static laser beam. As illustrated in Figures 2 and 3 of Chang '021, the width of the laser beam is usually larger than the width of two diaphragms and requires mirrors (directing means) and focusing lenses to reduce its size to the size of the two diaphragms. One of ordinary skill in the art would not expect to successfully oscillate this laser beam which has already been directed and focused. However, contrary to the low frequency oscillations taught by Esaka *et al.*, the present inventors have found that a high frequency oscillation, which they have claimed in the present application, addresses the problems of weld tracking and hot spots in small target edge welding and allows the process to occur more rapidly.

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For all of the above reasons, the present rejection should be removed.

Applicants have responded to all of Examiner's rejections. Reconsideration and allowance are respectfully requested.

Sincerely



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